(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 953 907 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
13.12.2017 Bulletin 2017/50

(21) Application number: **14749603.8**

(22) Date of filing: **07.02.2014**

(51) Int Cl.:
B01J 3/00 *(2006.01)* ***C02F 11/04*** *(2006.01)*
C02F 11/18 *(2006.01)*

(86) International application number:
PCT/NO2014/000017

(87) International publication number:
WO 2014/123426 (14.08.2014 Gazette 2014/33)

(54) METHOD FOR THE THERMAL PRETREATMENT OF ORGANIC MATERIAL FOR CONVERSION TO ENERGY

VERFAHREN ZUR THERMISCHEN VORBEHANDLUNG VON ORGANISCHEM MATERIAL ZUR ENERGIEUMWANDLUNG

PROCÉDÉ DE PRÉTRAITEMENT THERMIQUE DE MATIÈRE ORGANIQUE DESTINÉE À ÊTRE CONVERTIE EN ÉNERGIE

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **07.02.2013 NO 20130207**

(43) Date of publication of application:
16.12.2015 Bulletin 2015/51

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EP 2 953 907 B1

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The present invention relates to a method for the thermal pretreatment of organic material, in particular biomass for, conversion to energy.
In the internal process, thermal energy is used for transport of biomass only. The new method opens for a considerably shorter cycle time and essentially better utilisation of the hydrolysis reactor volume with regard to prior art. The method eliminates the use of pumps and level instrumentation and thereby considerably reduce cost and maintenance. The method involves a new system for the supply of fresh biomass to the preheating tank that improves the energy recovery. A main aim of the present invention is to reduce the amount of piping and valves that are subjected to wear and also eliminate the need for pumps for the transfer of biomass between the process tanks or to export to downstream energy conversion.
Thermal hydrolysis and steam explosion is a known method to break down biomass so that it is better suited to biological processes for energy conversion, such as, for example, digestion to biomass. The treatment of biomass with high temperatures occurs most often by the supply of steam at high pressure, typically 4-20 bar(g). This can be energy demanding, particularly if the biomass has a low dry matter content such as effluent sludge. To reduce the demand for energy it is important to recover as much heat as possible in the process. It can also be effective to treat the biomass at a higher dry matter content by dewatering it first. Biomass with a high dry matter content is difficult to transport in processing equipment. Large dimensions and robust solutions are required. The present invention uses thermal pressure energy only for the transport of the biomass and thereby reduces the risk for blockages or wear in the system.

[0002] There are several patented methods that describe both batch-wise and continuous processes for thermal hydrolysis. Batch-wise treatment of biomass gives acceptable sterilisation and disinfection to be able to document the required residence time at high temperature. This is different from continuous processes that can not document that all the biomass has been held long enough at the right temperature. Heating of the biomass ought to take place with the addition of fresh steam. The hydrolysis temperature, the temperature at which the biomass is treated, can normally be related to the saturation pressure of the steam in the hydrolysis reactor. After the thermal treatment, a fast and complete pressure reduction of the biomass is important for the use-value of the process. With a fast pressure reduction a steam explosion will take place in the biomass when the water becomes steam. Thus, the biomass is ripped apart and the required characteristics of the biomass are achieved, such as smaller particle size, a ripping apart of cell membrane and a lower viscosity.

[0003] In particular, there are two methods for batch-wise thermal hydrolysis that are known.

[0004] WO96/09882 (Solheim) describes an energy efficient process where the biomass is preheated in a preheating tank with the help of recycled steam from a downstream process in a preheating tank before the mass is pumped into one of several, parallel hydrolysis reactors. The biomass is supplied fresh steam for the heating and is held at a specified temperature and pressure in the hydrolysis reactor for the required time. Thereafter, the hydrolysis reactor is pressure relieved and steam is led back to the preheating tank for energy recovery. When the pressure in the hydrolysis reactor has sunk to a required level (typically 2-4 bar(a)), the steam return from the hydrolysis reactor to the preheating tank is closed. Thereafter the biomass is blown over into a pressure reduction tank at a low pressure (typically 1.2 bar(a)). The advantage with this system is that one can recover, at a relatively low pressure in the pressure reduction tank, a large part of the energy in the hydrolysis reactor after the thermal hydrolysis is completed. The pressure reduction in the hydrolysis reactor before it is blown over to the pressure reduction tank is described as necessary to reduce the erosion problems in the pipe system between the hydrolysis reactor and the pressure reduction tank.

[0005] US 6,966,989 (Højsgaard) does not use a preheating tank in contrast to Solheim, but has hydrolysis reactors in parallel that also operate as preheating tanks. This is achieved in that a hydrolysis reactor at a high pressure is relieved by letting steam over into a waiting hydrolysis reactor at a low pressure. When the pressure in these hydrolysis reactors has equalised, the steam transfer is shut and the hydrolysed biomass in the hydrolysis reactor is blown over into a low pressure reduction tank. There is no description of energy recovery from the pressure reduction tank. By filling a hydrolysis reactor with steam from a second hydrolysis reactor, one does not come far down in pressure and the energy recovery is thereby not optimal.

[0006] Common to the two systems is the use of pumps. This limits the capacity and leads to a poor utilisation of the hydrolysis reactor volume. The present invention utilises the hydrolysis reactor volume better in that the filling takes place with the help of vacuum and gravity in short pipes of a large dimension. This gives a typically ten times faster filling than with the use of a pump. The part of the total time which the hydrolysis reactor is active will thereby be larger in the present system than for other known methods for batch-wise hydrolysis.

[0007] With such a fast filling it is difficult to control the process to obtain the required level in the hydrolysis reactor. Traditional level measuring instruments are subjected to considerable process noise in such situations. Large control valves are also too slow to be able to control such fast filling processes. In the present invention a method is included to ensure the correct level, which includes simple geometrical limitations and an analysis of a high-frequency pressure signal.

[0008] The energy efficiency of Solheim is somewhat

higher than for the system of Højsgaard as the pressure in the pressure reduction tank is somewhat lower. But the pressure in the pressure reduction tank of Solheim is never lower than the required liquid height in the preheating tank which ensures condensation and energy recovery of return steam, typically 1.2-1.3 bar. The present invention improves this situation with the help of a dedicated steam return line from the pressure reduction tank of the steam phase in the preheating tank and an inlet arrangement for cold, fresh biomass which ensures optimal condensation of the return steam. The pressure in the pressure reduction tank can, in this way, become as low as typically 0.3-0.5 bar, something which leads to increased energy recovery and lower total consumption of steam.

A method and a device for treatment of biomass by the use of thermal hydrolysis are known from WO 03/043939. The biomass is preheated in a preheating step, whereupon the heating takes place with the use of fresh steam and with flash steam from a pressure reduction tank.

US2012111515 (Solheim et al.) describes a process for thermal hydrolysis an steam explosion of biomass having a dry matter content of for instance 5%, with a preheating step in a preheating tank, a hydrolysis step in a hydrolysis reactor, and a pressure reduction tank, where the flash steam from the pressure reduction tank being recycled to the preheating tank in order to preheat the biomass. However, this publication fails to describe the way the hydrolysis reactor is filled and how the recovery of flash steam is optimized.

The above mentioned aim and advantages are obtained with respect to the present invention by a method for the thermal pre-treatment of organic material, particularly biomass, for conversion to energy, wherein said method, which is according to claim 1, comprises a first preheating step with a preheating tank, a hydrolysis step with a hydrolysis reactor and a pressure reduction step with a pressure reduction tank, further comprising the following steps:

- in the preheating step, supply organic material with a dry matter content of 5 - 40%, preferably 10 - 25% to a preheating tank, and heat the organic material in the preheating tank with flash steam from the pressure reduction tank;
- provide a vacuum in the hydrolysis reactor by the supply of cold water in the hydrolysis reactor;
- open a supply valve between the preheating tank and the hydrolysis reactor, and transfer the heated organic material from the preheating tank to the hydrolysis reactor with the help of a vacuum and gravity, so that the hydrolysis reactor becomes essentially fully filled;

supply steam to the top of the hydrolysis reactor so that surplus organic material flows back from the hydrolysis reactor to the preheating tank via a pipe fitted with a valve, said pipe connecting the preheating tank with the hydrolysis reactor, said pipe sticking down some distance down in the hydrolysis reactor, the lower end of said pipe defining the required filling level in the hydrolysis reactor;

- measure the pressure in the hydrolysis reactor with the help of a sensitive high frequency pressure sensor that measures the pressure and analyses pressure oscillations in the hydrolysis reactor to detect when the required filling level in the hydrolysis reactor is reached;
- close the supply valve between the hydrolysis reactor and the preheating tank;
- supply new organic material to the preheating tank,
- heat the organic material in the hydrolysis reactor by the supply of steam and maintain the desired temperature for a sufficient length of time,
- open a blow valve between the hydrolysis reactor and the pressure reduction tank and transfer the treated organic material from the hydrolysis reactor to the pressure reduction tank and obtain a steam explosion as a consequence of the pressure difference between the hydrolysis reactor and the pressure reduction tank;
- lead the flash steam that is released in the steam explosion in the previous step via a steam return line to under the liquid level in the preheating tank and recover the heat by steam condensation in the organic material in the preheating tank,
- close the steam return line and open a steam return line from the pressure reduction tank to above the liquid level in the preheating tank to further reduce the pressure difference between the pressure reduction tank and the preheating tank beyond the pressure which the liquid column in the preheating tank represents.

Further advantageous features of the method are given in the dependent claims.

[0009] The invention will be described in more detail in the following with the help of an embodiment example with reference to the enclosed figures, where

Fig. 1 shows schematically an embodiment of a device for use with the method for pretreatment of organic material to energy conversion according to the invention;

Fig. 2 shows an example of a pressure signal by the return of surplus organic material from the hydrolysis reactor to the preheating tank; and

Fig. 3 shows schematically an example of the sequence.

Figure 1 shows schematically an embodiment of a device for use in the method for pretreatment of organic material according to the present invention.

Three tanks are connected in series; a preheating tank

4, a hydrolysis reactor 5 and a pressure reduction tank 6. The volume of the preheating tank 4 and the pressure reduction tank 6 is typically twice as large as the volume of the hydrolysis reactor 5. The preheating tank 4 and the hydrolysis reactor 5 can be placed directly above each other to reduce the piping to a minimum and use gravity for the transfer of the biomass from the one tank to the other. Alternatively, the preheating tank 4 can be placed essentially in parallel with the vertical axis of the hydrolysis reactor 5. The tanks can be isolated with valves. It is possible to supply steam to the hydrolysis reactor 5 and the pressure reduction tank 6. There are two steam return lines from the pressure reduction tank 6 to the preheating tank 4 to recover thermal energy supplied in the hydrolysis reactor 5 by thermal hydrolysis. There is a gas export pipe from the preheating tank to the export line 13 for organic material. An inlet arrangement 15 that breaks up the organic material is in the preheating tank 4, and supplies this with a large surface area.

[0010] Organic material 1, for example biomass, with a dry matter content of 5-40%, preferably 10-25%, is pumped into a preheating tank 4, possibly via a device 15 that increases the contact surface between the biomass and the steam in the pretreatment tank 4, and is preheated by flash steam from a pressure reduction tank 6, to 80-100 °C. After sufficient heating the biomass is thereafter led to a hydrolysis reactor 5. This is carried out by generating a vacuum in the hydrolysis reactor before the filling valve 7 between the preheating tank 4 and the hydrolysis reactor 5 opens. The vacuum is generated by condensing the steam that remains in the hydrolysis reactor 5 after the previous emptying of biomass from the hydrolysis reactor 5 to the pressure reduction tank 6. Condensation of steam takes place by injecting cold water 2A at the top of the hydrolysis reactor 5. (Typically, 50 litres will be able to condense all the steam and generate a full vacuum.) The preheating tank 4 can be placed directly above the hydrolysis reactor 5, either in the vertical axis of the hydrolysis reactor 5 or in parallel with it. When the filling valve 7 opens the vacuum in the hydrolysis reactor 5 and the pressure from the liquid column in the preheating tank 4 will result in a very fast transfer of the biomass from the preheating tank 4 to the hydrolysis reactor 5. A typical fill time is 10-180 seconds, preferably 20-40 seconds. This is much faster than other known solutions. Traditionally control valves and level measuring instruments are used for the control of the hydrolysis reactor volume. This is not possible for such fast filling, as with this apparatus. The correct level is ensured in the present invention in a different way.

[0011] The hydrolysis reactor 5 is completely filled. This is in principle not to be desired as there must be some space for fresh steam that condenses during the subsequent heating of the biomass in the hydrolysis reactor 5, typically 10-30% of the hydrolysis reactor volume. This is solved in the present invention in that the fill pipe 16 from the preheating tank 4 to the hydrolysis reactor 5 ends at a defined height inside the hydrolysis reactor. This height defines the desired fill volume in the hydrolysis reactor 5 before the heating of the biomass commences. The necessary expansion volume above the biomass is then ensured by supplying fresh steam 3A at the top of the hydrolysis reactor 5 while the filling valve 7, between the preheating tank 4 and the hydrolysis reactor 5, is still open. Thus the surplus biomass flows back into the preheating tank 4 before the filling valve 7 between the tanks is closed.

[0012] This volume can alternatively be provided by a side-mounted valve and an external line to the preheating tank 4.

[0013] The present invention minimises the use of steam for level control of the hydrolysis reactor 5. Surplus biomass is out of the hydrolysis reactor 5 and the filling valve 7 closes when a sensitive, high frequency pressure sensor (not shown in the figures) in the hydrolysis reactor 5 indicates that steam is let out of the hydrolysis reactor and up into the fill pipe 16 to the preheating tank 4. This is detected by pressure oscillations when the steam bubbles from the hydrolysis reactor 5 condense and collapse in the fill pipe. A high frequency registering of the pressure in the hydrolysis reactor connected with an analysis of the pressure oscillations are used to determine that the required level has been reached in the hydrolysis reactor 5. In this way one eliminates the need for complex level measuring instrumentation in the hydrolysis reactor 5.

[0014] Figure 2 shows a typical pressure signal at the return of surplus biomass from the hydrolysis reactor 5 to the preheating tank 4. The pressure increases quickly in the start phase (shown by I in fig. 2) when the steam accelerates the biomass from the hydrolysis reactor 5 up into the fill pipe 16. The sludge starts to flow back to the preheating tank 4. The pressure increases more evenly (shown by II in fig. 2), while the biomass is returned to the preheating tank 4 and the static pressure between the hydrolysis reactor and the preheating tank increases in that the liquid level in the preheating tank 4 increases and the liquid level in the hydrolysis reactor 5 decreases.

[0015] When the liquid level in hydrolysis reactor 5 is sunk to the end of the fill pipe 16, steam from the top of the hydrolysis reactor will go up the fill pipe to the preheating tank. This steam rises up into colder biomass and will condense. This creates larger pressure pulses (shown by III in fig. 2). These pulses indicate that the hydrolysis reactor 5 has the right liquid level before the heating of the biomass can start.

[0016] The biomass in the hydrolysis reactor 5 is heated up to the desired hydrolysis pressure, typically 3-16 bar, preferably 3-7 bar for the treatment of effluent sludge and wet organic waste, preferably 10-12 bar for the treatment of prion-containing biomass and preferably 12-16 bar for the treatment of lignocellulose-containing biomass, by the supply of fresh steam 3B to the hydrolysis reactor 5, and is thereafter held at this pressure for a predetermined time, typically 20-30 minutes for the treatment of effluent sludge and wet organic waste, preferably 60-120 minutes for the treatment of prion-containing bi-

omass and preferably 5-20 minutes for the treatment of lignocellulose-containing biomass. Thereafter, the blowing valve 10 is opened and the biomass is blown from the hydrolysis reactor 5 at high pressure to the pressure reduction tank 6 at low pressure. Thereby a steam explosion takes place in the biomass. The flash steam that is released in the steam explosion in the pressure reduction tank 6 is led back to below the liquid level in the preheating tank 4 via a pressure reduction pipe 9. The surplus heat from the pressure reduction tank 6 is recovered by the steam condensation in the biomass in the preheating tank 4.

[0017] After the hydrolysis reactor 5 has been emptied, the blow valve 10 is closed and it is ready for a new filling of the hydrolysis reactor 5.

[0018] An advantage with a one-hydrolysis reactor system is that one can use the preheating tank 4 and the pressure reduction tank 6 for other purposes while the hydrolysis reactor 5 is filled with biomass for thermal hydrolysis. As soon as the blow valve 10 is closed and the pressure between the pressure reduction tank 6 and preheating tank 4 is in balance via the steam return line 9, this is closed and a steam return line 11 is opened from the pressure reduction tank 6 to the gas phase in the preheating tank 4. Thereby, the pressure difference between the pressure reduction tank 6 and the preheating tank 4 can be reduced beyond the pressure which the liquid column in the preheating tank 4 represents, this gives a typical 0.1-0.2 bar further reduction. This means that the pressure in the pressure reduction tank 6 is independent of the liquid level in the preheating tank 4. The lower the pressure in the pressure reduction tank 6, the lower the temperature of the biomass that goes out of the pressure reduction tank 6. At the same time as the steam return line 11 is open, new biomass 1 is pumped into the top of the preheating tank 4. This biomass is cold, typically 5-40 °C. The steam in the preheating tank 4 is condensed on the new biomass, the biomass is preheated and reduces the pressure in the preheating tank 4 and the pressure reduction tank 6 further. This is an important function for optimal energy efficiency.

[0019] To optimise the steam condensation on the new biomass a device 15 is placed in the preheating tank 4 that gives the biomass a large contact surface with the gas phase in the preheating tank 4. The device 15 breaks up the biomass into thin film fragments or beams.

[0020] The level in the pressure reduction tank 6 must be reduced sufficiently before the next emptying of the hydrolysis reactor 5. This takes place by closing the steam return line 11 and filling fresh steam 3C into the gas phase of the pressure reduction tank 6. When the pressure is sufficient (typically 2-4 bar) to transport the treated biomass to desired downstream equipment via the outlet pipe 13, the outlet valve 12 is opened and the level in the pressure reduction tank 6 is reduced to the required minimum level before the outlet valve 12 closes again.

[0021] Volatile and inert process gasses are released, which are formed during the thermal pretreatment that takes place in the hydrolysis reactor 5. These gases are transported via the pressure reduction tank 6 to the preheating tank 4. The process gases must be removed from the hydrolysis plant to prevent accumulation and reduced efficiency of the plant. Normally these gases will be sent to biological degradation via the outlet pipe 13.

[0022] Before new biomass is supplied to the preheating tank 4, the process gas from the preheating tank 4 will be led to the outlet pipe 13 via the process gas pipe 14. This process gas pipe 14 is opened when the pressure in the preheating tank 4 is sufficiently high, typically 2-4 bar. The required pressure is reached with the supply of fresh steam 3C to the pressure reduction tank 6. When the process gas has been vented out via the process gas pipe 14, this closes. The steam return line 11 closes.

[0023] Before the next emptying of the hydrolysis reactor 5 to the pressure reduction tank 6, it is important that the pressure in the preheating tank 4 is as low as possible to recover as much flash steam as possible. This is achieved by steam condensation in the preheating tank 4 by injecting cold water 2B into this. The low pressure in the preheating tank 4, and thereby in the pressure reduction tank 6, results in an increased amount of flash steam from the biomass in the pressure reduction tank 6 and thereby the lowest possible temperature of the biomass in the outlet 13.

[0024] Figure 3 shows schematically an example of a typical sequence for the three tanks.

Claims

1. Method for the thermal pretreatment of organic material, in particular biomass, for conversion to energy, said method incorporating a first preheating step with a preheating tank (4), a hydrolysis step with a hydrolysis reactor (5) and a pressure reduction step with a pressure reduction tank (6),
characterised in that the method comprises the following steps:

   - in the preheating step, supply organic material (1) with a dry matter content of 5 - 40%, preferably 10 - 25 % to a preheating tank (4), and heat the organic material (1) in the preheating tank (4) with flash steam from the pressure reduction tank (6),
   - provide a vacuum in the hydrolysis reactor (5) by the supply of cold water (2A) in the hydrolysis reactor (5),
   - open the supply valve (7) between the preheating tank (4) and the hydrolysis reactor (5), and transfer the heated organic material from the preheating tank (4) to the hydrolysis reactor (5) with the help of vacuum and gravity, so that the hydrolysis reactor (5) becomes essentially fully filled,

- supply steam (3a) to the top of the hydrolysis reactor (5) so that surplus organic material flows back from the hydrolysis reactor (5) to the preheating tank (4) via a pipe (16) fitted with a valve (7), said pipe (16) connecting the preheating tank (4) with the hydrolysis reactor (5), said pipe (16) sticking some distance down in the hydrolysis reactor (5), the lower end of said pipe (16) defining the required filling level in the hydrolysis reactor (5)
- measure the pressure in the hydrolysis reactor (5) with the help of a sensitive high-frequency pressure sensor that measures the pressure and analyses pressure oscillations in the hydrolysis reactor to detect when the required filling level in the hydrolysis reactor (5) is reached,
- close the supply valve (7) between the hydrolysis reactor (5) and the preheating tank (4),
- supply new organic material (1) to the preheating tank (4),
- heat the organic material in the hydrolysis reactor (5) by the supply of steam (3B) and maintain the desired temperature for a sufficient length of time,
- open a blow valve (10) between the hydrolysis reactor (5) and the pressure reduction tank (6) and transfer the treated organic material from the hydrolysis reactor (5) to the pressure reduction tank (6) and obtain a steam explosion as a consequence of the pressure difference between the hydrolysis reactor (5) and the pressure reduction tank (6),
- lead the flash steam that is released in the steam explosion in the previous step via a steam return line (9) to under the liquid level in the preheating tank (4) and recover the heat by steam condensation in the organic material in the preheating tank (4),
- close the steam return line (9) and open a steam return line (11) from the pressure reduction tank (6) to above the liquid level in the preheating tank (4) to further reduce the pressure difference between the pressure reduction tank (6) and the preheating tank (4) beyond the pressure which the liquid column in the preheating tank (4) represents.

2. Method according to claim 1,
characterised in that the method comprises a step in which an inlet arrangement (15) placed in the preheating tank (4) breaks up the organic material (1) that is supplied to the preheating tank (4) with an increased surface area and thus with an increased contact surface with said flash steam from the pressure reduction tank (6).

3. Method according to any of the preceding claims,
characterised in that the organic material (1) in the preheating tank (4) is heated to 80-100 °C.

4. Method according to claim 1,
characterised in that the pipe (16) sticks down vertically in the hydrolysis reactor (5) or sticks into the hydrolysis reactor (5) through an upper sidewall thereof, the distance between the end of the pipe (16) and the bottom of the hydrolysis reactor (5) defines said required filling level in the hydrolysis reactor (5).

Patentansprüche

1. Verfahren zur thermischen Vorbehandlung von organischem Material, insbesondere Biomasse, zur Umwandlung in Energie, wobei das Verfahren einen ersten Vorheizschritt mit einem Vorheiztank (4), einen Hydrolyseschritt mit einem Hydrolysereaktor (5) und einen Druckreduktionsschritt mit einem Druckreduktionstank (6) umfasst,
dadurch gekennzeichnet, dass das Verfahren die folgenden Schritte umfasst:

- im Vorheizschritt, Zuführen von organischem Material (1) mit einem Trockenmassegehalt von 5-40 %, vorzugsweise 10-25 % in einen Vorheiztank (4) und Erwärmen des organischen Materials (1) in dem Vorheiztank (4) mit Wasserdampf aus einem Druckreduktionstank (6),
- Bereitstellen eines Vakuums in dem Hydrolysereaktor (5) durch die Zufuhr von kaltem Wasser (2A) in den Hydrolysereaktor (5),
- Öffnen des Zufuhrventils (7) zwischen dem Vorheiztank (4) und dem Hydrolysereaktor und Überführen des erwärmten organischen Materials aus dem Vorheiztank (4) in den Hydrolysereaktor mit Hilfe von Vakuum und Schwerkraft, so dass der Hydrolysereaktor im Wesentlichen vollständig befüllt wird,
- Zuführen von Dampf (3a) von oben in den Hydrolysereaktor (5), so dass überschüssiges organisches Material aus dem Hydrolysereaktor (5) in den Vorheiztank (4) über ein Rohr (16) zurückfließt, auf das ein Ventil (7) aufgesetzt ist, wobei das Rohr (16) den Vorheiztank (4) mit dem Hydrolysereaktor (5) verbindet, wobei das Rohr (16) ein Stück nach unten in den Hydrolysereaktor (5) hineinsteht, wobei das untere Ende des Rohrs (16) das erforderliche Füllniveau in dem Hydrolysereaktor (5) definiert,
- Messen des Drucks in dem Hydrolysereaktor (5) mit Hilfe eines empfindlichen Hochfrequenzdrucksensors, der den Druck misst und Druckschwankungen in dem Hydrolysereaktor auswertet, um nachzuweisen, wann das erforderliche Füllniveau in dem Hydrolysereaktor (5) erreicht ist.

- Schließen des Zufuhrventils (7) zwischen dem Hydrolysereaktor und dem Vorheiztank (4),
- Zuführen von neuem organischen Material (1) in den Vorheiztank (4),
- Erwärmen des organischen Materials in dem Hydrolysereaktor durch Zufuhr von Dampf (3B) und Halten der gewünschten Temperatur für eine ausreichend lange Zeit,
- Öffnen eines Ablassventils zwischen dem Hydrolysereaktor (5) und dem Druckreduktionstank (6) und Überführen des behandelten organischen Materials aus dem Hydrolysereaktor (5) in den Druckreduktionstank (6) und Erhalten einer Dampfexplosion als Folge der Druckdifferenz zwischen dem Hydrolysereaktor (5) und dem Druckreduktionstank (6),
- Leiten des Wasserdampfes, der in dem vorherigen Schritt in der Dampfexplosion freigesetzt worden ist, über eine Dampfrücklaufleitung (9) bis unter das Flüssigkeitsniveau in Vorheiztank (4) und Rückgewinnen der Wärme durch Dampfkondensation in dem organischen Material im Vorheiztank (4),
- Schließen der Dampfrücklaufleitung (9) und Öffnen einer Dampfrücklaufleitung (11) aus dem Druckreduktionstank (6) bis über das Flüssigkeitsniveau im Vorheiztank (4), um die Druckdifferenz zwischen dem Druckreduktionstank (6) und dem Vorheiztank (4) weiter über den Druck hinaus zu reduzieren, den die Flüssigkeitssäule im Vorheiztank (4) darstellt.

2. Verfahren nach Anspruch 1,
dadurch gekennzeichnet, dass das Verfahren einen Schritt umfasst, in dem eine im Vorheiztank (4) angeordnete Einlassanordnung (15) das organische Material (1), das dem Vorheiztank (4) zugeführt wird, mit einem erhöhten Oberflächenbereich und damit mit einem erhöhten Kontaktflächenbereich mit dem Wasserdampf aus dem Druckreduktionstank (6) aufschließt.

3. Verfahren nach einem der vorangehenden Ansprüche,
dadurch gekennzeichnet, dass das organische Material (1) in dem Vorheiztank (4) auf 80-100 °C erwärmt wird.

4. Verfahren nach Anspruch 1,
dadurch gekennzeichnet, dass das Rohr (16) vertikal in dem Hydrolysereaktor (5) nach unten steht oder in den Hydrolysereaktor (5) durch eine obere Seitenwand hineinsteht, wobei der Abstand zwischen dem Ende des Rohrs (16) und dem Boden des Hydrolysereaktors (5) das erforderliche Füllniveau im Hydrolysereaktor (5) definiert.

Revendications

1. Procédé pour le prétraitement thermique de matière organique, en particulier une biomasse, destinée à être convertie en énergie, ledit procédé incorporant une première étape de préchauffage dans une cuve de préchauffage (4), une étape d'hydrolyse dans un réacteur d'hydrolyse (5) et une étape de réduction de pression dans une cuve de réduction de pression (6),
caractérisé en ce que le procédé comprend les étapes suivantes :

- lors de l'étape de préchauffage, l'apport de matière organique (1) avec une teneur en matières sèches de 5 à 40 %, de préférence de 10 à 25 % à une cuve de préchauffage (4), et le chauffage de la matière organique (1) dans la cuve de préchauffage (4) avec une vapeur de détente provenant de la cuve de réduction de pression (6),
- la création d'un vide dans le réacteur d'hydrolyse (5) par l'apport d'eau froide (2A) dans le réacteur d'hydrolyse (5),
- l'ouverture de la vanne d'alimentation (7) entre la cuve de préchauffage (4) et le réacteur d'hydrolyse (5), et le transfert de la matière organique chauffée depuis la cuve de préchauffage (4) jusqu'au réacteur d'hydrolyse (5) à l'aide du vide et de la gravité, de telle sorte que le réacteur d'hydrolyse (5) devient essentiellement complètement rempli,
- l'apport de vapeur (3a) dans le haut du réacteur d'hydrolyse (5) de telle sorte que le surplus de matière organique reflue du réacteur d'hydrolyse (5) jusqu'à la cuve de préchauffage (4) par l'intermédiaire d'un conduit (16) équipé d'une vanne (7), ledit conduit (16) raccordant la cuve de préchauffage (4) au réacteur d'hydrolyse (5), ledit conduit (16) s'enfonçant d'une certaine distance dans le réacteur d'hydrolyse (5), l'extrémité inférieure dudit conduit (16) définissant le niveau de remplissage requis dans le réacteur d'hydrolyse (5)
- la mesure de la pression dans le réacteur d'hydrolyse (5) à l'aide d'un capteur de pression haute-fréquence sensible qui mesure la pression et analyse les oscillations de pression dans le réacteur d'hydrolyse afin de détecter le moment où le niveau de remplissage requis dans le réacteur d'hydrolyse (5) est atteint,
- la fermeture de la vanne d'alimentation (7) entre le réacteur d'hydrolyse (5) et la cuve de préchauffage (4),
- l'apport de nouvelle matière organique (1) à la cuve de préchauffage (4),
- le chauffage de la matière organique dans le réacteur d'hydrolyse (5) par l'apport de vapeur

(3B) et le maintien de la température souhaitée pendant une période suffisante,
- l'ouverture d'une vanne de soufflage (10) entre le réacteur d'hydrolyse (5) et la cuve de réduction de pression (6) et le transfert de la matière organique traitée depuis le réacteur d'hydrolyse (5) jusqu'à la cuve de réduction de pression (6) et l'obtention d'une explosion de vapeur en conséquence de la différence de pression entre le réacteur d'hydrolyse (5) et la cuve de réduction de pression (6),
- la conduite de la vapeur de détente qui est relâchée lors de l'explosion de vapeur à l'étape précédente par l'intermédiaire d'une conduite de retour de vapeur (9) jusque sous le niveau de liquide dans la cuve de préchauffage (4) et la récupération de la chaleur par condensation de vapeur dans la matière organique dans la cuve de préchauffage (4),
- la fermeture de la conduite de retour de vapeur (9) et l'ouverture d'une conduite de retour de vapeur (11) depuis la cuve de réduction de pression (6) jusqu'au-dessus du niveau de liquide dans la cuve de préchauffage (4) afin de réduire encore la différence de pression entre la cuve de réduction de pression (6) et la cuve de préchauffage (4) au-delà de la pression que représente la colonne de liquide dans la cuve de préchauffage (4).

2. Procédé selon la revendication 1,
caractérisé en ce que le procédé comprend une étape dans laquelle un agencement d'entrée (15) placé dans la cuve de préchauffage (4) brise la matière organique (1) qui est apportée à la cuve de préchauffage (4) avec une superficie accrue et ainsi avec une surface de contact accrue avec ladite vapeur de détente depuis la cuve de réduction de pression (6).

3. Procédé selon l'une quelconque des revendications précédentes,
caractérisé en ce que la matière organique (1) dans la cuve de préchauffage (4) est chauffée à 80-100 °C.

4. Procédé selon la revendication 1,
caractérisé en ce que le conduit (16) s'enfonce verticalement dans le réacteur d'hydrolyse (5) ou s'enfonce dans le réacteur d'hydrolyse (5) à travers une paroi latérale supérieure de celui-ci, la distance entre l'extrémité du conduit (16) et le fond du réacteur d'hydrolyse (5) définit ledit niveau de remplissage requis dans le réacteur d'hydrolyse (5).

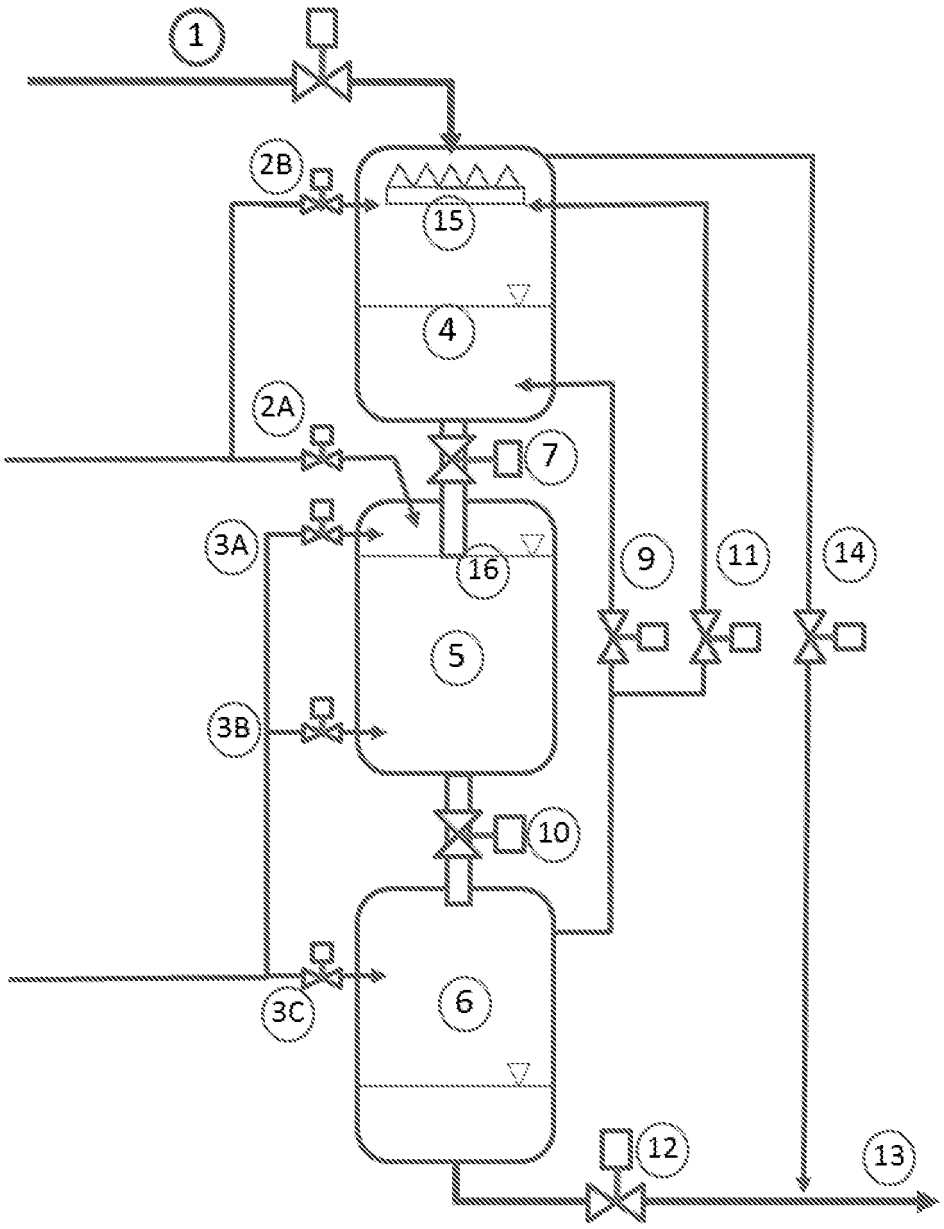


FIG. 1

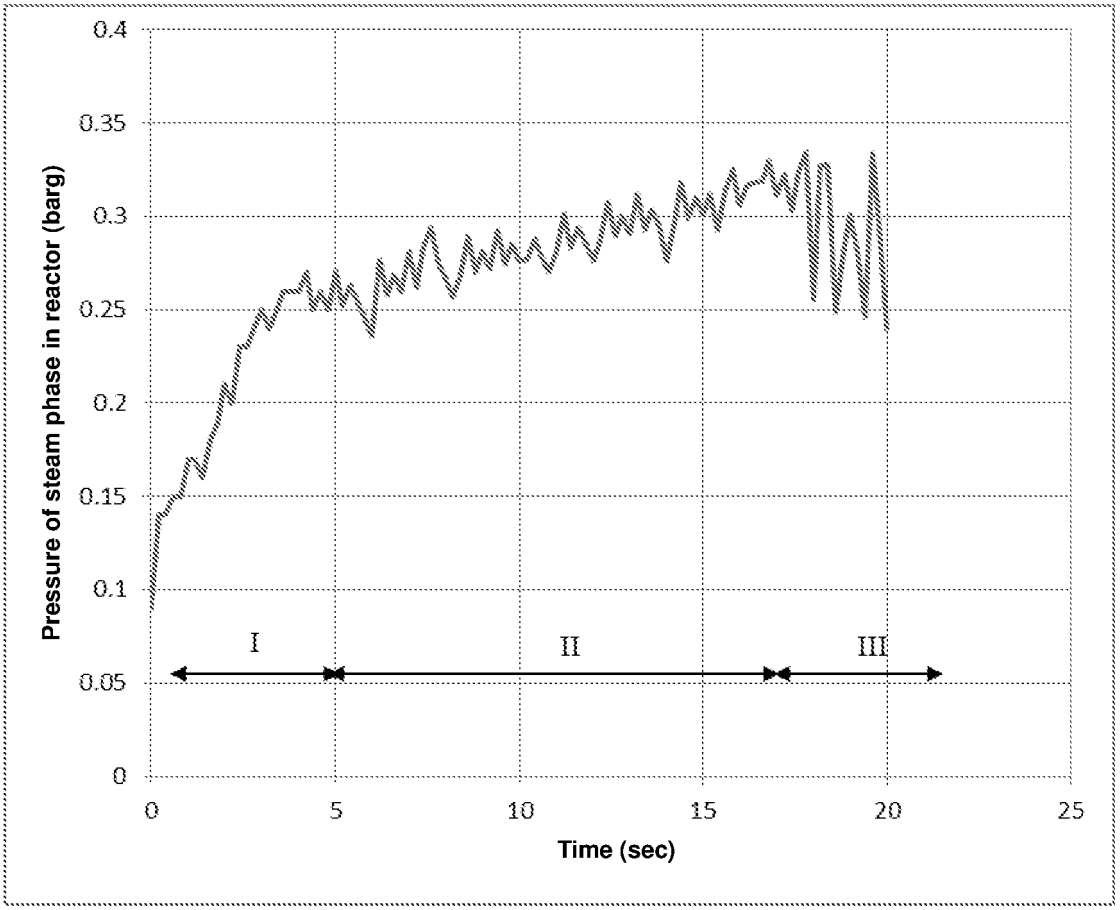

Pressure of steam phase in reactor (barg)
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
I
II
III
0
5
10
15
20
25
Time (sec)

FIG. 2

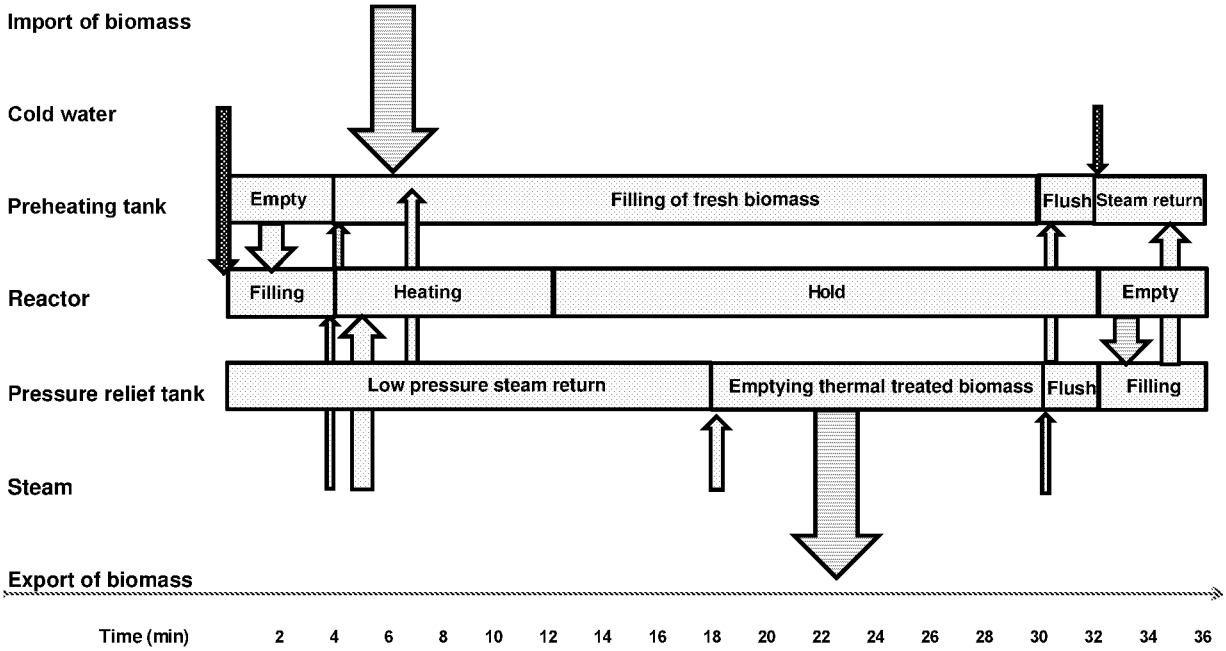

Import of biomass
Cold water
Preheating tank
Reactor
Pressure relief tank
Steam
Export of biomass
Empty
Filling of fresh biomass
Flush
Steam return
Filling
Heating
Hold
Empty
Low pressure steam return
Emptying thermal treated biomass
Flush
Filling
Time (min)
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36

FIG. 3

REFERENCES CITED IN THE DESCRIPTION

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